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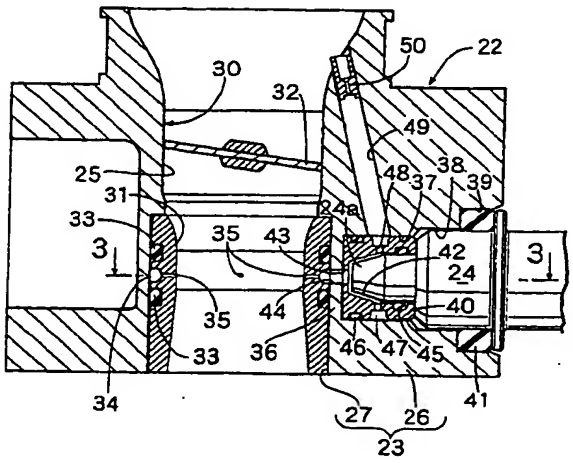
(54) Engine fuel supply system

(57) To promote atomization of fuel in an engine fuel supply system, a fuel injection valve (24) fitted in an intake path organizer (23) forming an intake path communicating with an air cleaner has a fuel passage for guiding fuel from the fuel injection valve (24), a fuel induction port (35) having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed (49) passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer.

A fuel induction port (35) opens to an intake path (30) in a direction orthogonal to air flow circulating in the intake path (30).

Fig. 2



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Description

[0001] The present invention relates to an engine fuel supply system, with a fuel injection valve fitted in an intake path organizer forming an intake path communicating with an air cleaner, having a fuel passage for guiding fuel from the fuel injection valve, a fuel induction port having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer.

[0002] A fuel supply system of the related art is already known, for example, from Japanese Patent Laid-open No. Hei. 5-26132.

[0003] With type of fuel supply system, fuel supplied from a fuel injection valve in an air flow circulating in an intake path is sucked and atomized, and at the same time atomization of the fuel is promoted by assist air from an air bleed passageway. It is possible to cause a reduction in the injection pressure of the fuel injection valve, and there is no need to control fuel injection timing of the fuel injection valve with high precision. However, with the fuel supply system of the related art, the fuel induction port opens facing a downstream side of an air flow inside the intake path, and it is difficult to say that there is favorable atomization of fuel inside the air flow, and it is desirable to significantly promote fuel atomization in order to bring about reduction in fuel consumption, improved exhaust quality, and improved engine output.

[0004] The present invention has been conceived in view of the above described problems, and the object of the present invention is to provide an engine fuel injection system that can promote fuel atomization much more.

[0005] In order to implement the above described object, the invention as disclosed in claim 1 provides an engine fuel supply system, with a fuel injection valve fitted in an intake path organizer forming an intake path communicating with an air cleaner, having a fuel passage for guiding fuel from the fuel injection valve, a fuel induction port having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer, wherein the other end of the fuel induction port is opened to the intake path in a direction orthogonal to an air flow circulating in the intake path.

[0006] According to the invention of claim 1, the air flow and fuel sucked to the air flow side from the fuel induction port collide with each other because the fuel induction port opens in a direction orthogonal to air flow of the intake path, to effectively atomize the fuel, and by promoting atomization of the fuel it becomes possible to reduce fuel consumption and it also becomes possible to improve exhaust quality and engine output.

[0007] The invention as disclosed in claim 2 is substantially the invention of claim 1, wherein the fuel induction port is provided in the intake path organizer opening to an inner surface of the intake path, and with this construction, it is possible to avoid increasing airflow resistance without providing a structure that interferes with flow inside the intake path according to the arrangement of the fuel induction port.

[0008] The invention disclosed in claim 3 is basically the invention of claim 2, wherein the other ends of a plurality of fuel induction ports open to an inner surface of the intake path at mutually opposite positions, and with this construction it becomes possible to prevent fuel sticking to the inner surface of the intake path and to much more effectively atomize the fuel, by causing collision of fuel sucked in to the air flow side from the mutually opposite fuel induction ports, and it is possible to significantly reduce fuel consumption as well as significantly improve exhaust quality and engine output.

[0009] The invention disclosed in claim 4 is an engine fuel supply system, with a fuel injection valve fitted in an intake path organizer forming an intake path communicating with an air cleaner, having a fuel passage for guiding fuel from the fuel injection valve, a fuel induction port having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer, wherein a narrowed section constituting part of the intake path is provided in the intake path organizer with a smaller internal diameter than the intake path at an upstream side of the narrowed section, and the other end of the fuel induction port opens to an inner surface of the narrowed section in a direction orthogonal to an air flow circulating in the narrowed section.

[0010] With the invention of claim 4, by having the fuel induction port opening to an inner surface of a narrowed section in a direction orthogonal to air flow of the intake path, it is possible to more effectively suck fuel to the air flow side from the fuel induction port using negative intake pressure of the narrowed section, it becomes possible to cause collision of the air flow and sucked fuel to more effectively atomize fuel, and it becomes possible to reduce fuel consumption as well as improving exhaust quality and engine output.

[0011] According to the invention as disclosed in claim 1, the air flow of the intake path and fuel sucked to the air flow side from the fuel induction port collide with each other making it possible to effectively atomize the fuel, it becomes possible to reduce fuel consumption and it also becomes possible to improve exhaust quality

and engine output.

[0012] According to the invention as disclosed in claim 2, it is possible to avoid increasing ventilation resistance, and it is possible to significantly improve engine output.

[0013] According to the invention as disclosed in claim 3, it is possible to prevent fuel sticking to the inner surface of the intake path and to much more effectively atomize fuel by causing fuel streams sucked from the mutually opposite fuel induction ports to the air flow side to collide with each other, it is possible to significantly reduce fuel consumption and it is possible to significantly improve exhaust quality and engine output.

[0014] According to the invention as disclosed in claim 4, it becomes possible to effectively suck fuel from the fuel induction port to the air flow side using negative intake pressure at the narrowed section, it becomes possible to more effectively atomize fuel by causing air flow of the narrowed section and sucked fuel to collide with each other, it is possible to reduce fuel consumption and it is possible to improve exhaust quality and engine output.

[0015] Embodiments of the present invention will now be described in the following with reference to the attached drawings.

Fig. 1 is a cut-away cross section showing an engine intake system.
Fig. 2 is an enlarged vertical cross section of an intake path organizer
Fig. 3 is a cross section along line 3 - 3 in Fig. 2
Fig. 4 is a drawing showing a relationship between fuel supply pressure and exhaust quality.
Fig. 5 is a drawing showing a relationship between fuel injection timing and exhaust quality.
Fig. 6 is a drawing showing a relationship between brake-mean effective pressure and exhaust quality.
Fig. 7 is a cross sectional cut-away drawing of an engine intake system of a second embodiment.
Fig. 8 is a cross sectional cut-away drawing of an engine intake system of a third embodiment.
Fig. 9 is a cross sectional cut-away drawing of an engine intake system of a fourth embodiment.

[0016] A first embodiment of the present invention is shown in Fig. 1 - Fig. 6. Fig. 1 is a cut-away cross section showing an engine intake system, Fig. 2 is an enlarged vertical cross section of an intake path organizer, Fig. 3 is a cross section along line 3 - 3 in Fig. 2, Fig. 4 is a drawing showing a relationship between fuel supply pressure and exhaust quality, Fig. 5 is a drawing showing a relationship between fuel injection timing and exhaust quality, and Fig. 6 is a drawing showing a relationship between brake-mean effective pressure and exhaust quality.

[0017] First of all, in Fig. 1, an engine E comprises a cylinder block 11 and a cylinder head 12 joined to the cylinder block 11, and a combustion chamber 15 is formed between a piston 14 slidably fitted in a cylinder bore 13 provided in the cylinder block 11, and the cylinder head 12.

[0018] An intake port 16 and an exhaust port 17 capable of communicating with the combustion chamber are provided in the cylinder head 12, an intake valve 18 for switching between communication and disconnection between the intake port 16 and the combustion chamber, and an exhaust valve 17 for switching between communication and disconnection between the exhaust port and the combustion chamber, are supported in the cylinder head 12 so as to enable opening and closing operations, and the intake valve 18 and the exhaust valve 19 are driven to open and close by a conventional valve mechanism 20.

[0019] A fuel supply system 22 is connected to the intake port 16 via an intake pipe 21. This fuel supply system 22 comprises an intake path organizer 23 and a fuel injection valve 24 mounted in the intake path organizer.

[0020] In Fig. 2, the intake path organizer 23 is comprised of an intake path main component 26 having a passageway 25, and a narrowed section 27 fixed to the intake path main component 26 by fitting into a downstream side of the passageway 25. The intake path main component 23 includes an intake path 30 which has an upper end communicating with an air cleaner 29 via an intake hose 28, and a lower end communicating with the intake pipe 21. The intake path 30 is comprised of a section for removing sections to which the narrowing member 27 in the passageway 25 is fitted, and a narrowed section 31 formed at an inner surface of the narrowing member 27. The narrowed section 31 is formed having a smaller internal diameter than the intake path 30 further upstream than the narrowed section 31, namely smaller than the passageway 25.

[0021] A butterfly type throttle valve 32 for controlling the opening extent of the intake path 30 is rotatably supported in the intake path main component 26 of the intake path organizer further upstream than the narrowed section 31.

[0022] With reference to Fig. 3, an annular groove is provided around the outer periphery of the narrowing member 27, and a pair of annular seal members 33, 33 are fitted sandwiching the annular groove. The narrowing member 27 is fitted into the intake path main component 26, and in a fixed state an annular fuel passage 34 is formed between the narrowing member 27 and the intake path main component 26 using the annular groove, with both sides of the fuel passageway 34 being sealed by the seal members 33, 33 interposed between the intake path main component 26 and the narrowing member 27. Specifically, an annular fuel passageway 34 concentrically surrounding the intake path 30 is provided in the intake path organizer 23 at sections corresponding to the narrowed section 31.

[0023] A plurality of, for example four, fuel induction ports 35, 35... having one end leading to the fuel pas-

sage 34 and the other end opening to an inner surface of the narrowed section 31 are provided so that other end opening sections of respective fuel induction ports 35, 35...are opposite to each other. Also, each of the fuel induction ports 35, 35... is arranged in a plane orthogonal to the axis of the narrowed section 31, and other ends of each of the fuel induction ports 35, 35... open to an inner surface of the narrowed section 31 in a direction orthogonal to a flow direction of air circulating in the narrowed section 31.

[0024] A small diameter hole 27 having an end wall 36 at an inner end, an intermediate diameter hole 38, having a larger diameter than the small diameter hole 37 and with an inner end leading coaxially to an outer end of the small diameter hole 37, and a large diameter hole 39 having a larger diameter than the intermediate diameter hole 38, an inner end leading coaxially to an outer end of the intermediate hole 38 and with an opening outer end, are provided in the intake path main component 26 of the intake path organizer 23, and a cylindrical collar 40 having a closed inner end is fitted into the small diameter hole 37.

[0025] The tip of the fuel injection valve 24 is inserted into the intermediate diameter hole 38 and the large diameter hole 39 with an annular seal member 41 interposed between the large diameter hole 39 and the fuel injection valve. A cylindrical fuel squirting nozzle 24a provided at the extreme end of the fuel injection valve 24 is fitted into the collar 40.

[0026] A bleed chamber 42 is formed between the fuel squirting nozzle 24a and the collar 40, and this bleed chamber 42 communicates with the fuel passage 34 through a communicating hole 43 provided in a tip blocking section of the collar 40 and a communicating hole 44 provided in the end wall 36 coaxially with the communicating hole 43. An annular seal member 45 is interposed between an outer end of the collar 40 and the fuel squirting nozzle 24a, and an annular sealing member 46 for pressing against the inner surface of the small diameter hole is fitted onto the outer surface of the inner end of the collar 40.

[0027] An annular recess is provided in an outer surface of a middle part of the collar 40 for forming an annular chamber 47, between the inner surface of the small diameter hole 37 and the collar 40. A plurality of communicating holes 48, 48 communicating between the annular chamber 47 and the bleed chamber 42 are also provided in the collar 40.

[0028] An air bleed passage 49 having one end leading to the intake path 30 at a point further upstream than each of the fuel induction ports 35, 35..., in this embodiment further upstream than the throttle valve 32, is provided in the fuel path main component member 26 of the fuel path organizer 23 so that the other end leads to the annular chamber 47, and an air jet 50 is press-fitted into one end of this air bleed passage 49. Specifically, the other end of the air bleed passage 40 having one end communicating with the intake path 30 upstream of the throttle valve 32 communicates with the fuel passage 34 through the annular chamber 47, the communicating holes 48, 48..., the bleed chamber 42 and the communicating holes 43 and 44.

[0029] Operation of this first embodiment will now be described. Fuel injected from the fuel injection valve 24 is metered by the air jet 50 inside the bleed chamber 42, mixed with assist air supplied from the air bleed passage 49 and guided to the fuel passage 34. The fuel is then sucked from the fuel induction ports 35, 35... to the intake path 30 by an air flow circulating in the intake path 30 and atomized. Also, each of the fuel induction ports 35, 35... opens to the intake path 30 in a direction orthogonal to the air flow circulating in the intake path 30, and the fuel is effectively atomized because of collision between the air flow circulating in the intake path 30 and the fuel sucked to the air flow side from the fuel induction holes 35, 35..., to promote fuel atomization, which makes it possible to reduce fuel consumption and enables improvement in exhaust quality and engine output.

[0030] Since the fuel induction holes 35, 35... open to the inner surface of the intake path 30, no structure disturbing flow inside the intake path 30 accompanying arrangement of the fuel induction ports 35, 35... is provided. Accordingly, it is possible to avoid increasing the ventilation resistance of the intake path, and it is possible to significantly improve engine output.

[0031] The fuel induction ports 35, 35... open to an inner surface of the intake path 30 at positions opposite to each other, which means that by causing collision between respective fuel streams sucked to the air flow side from the mutually opposite fuel induction holes 35, 35... it is possible to prevent fuel sticking to the inner surface of the intake path 30, it becomes possible to significantly reduce fuel consumption and it is possible to improve exhaust quality and engine output.

[0032] In particular, the narrowed section 31 constituting part of the intake path 30 is provided in the intake path organizer 23 having an internal diameter smaller than the intake path 30 further upstream than the narrowed section 31, and the fuel induction holes 35, 35... open to an inner surface of the narrowed section 31 in directions orthogonal to air flow circulating in the narrowed section 31, which means that it becomes possible to more effectively suck fuel from the fuel induction holes 35, 35... to the air flow side using negative intake pressure at the narrowed section 31, it becomes possible to significantly reduce fuel consumption and it is possible to improve exhaust quality and engine output.

[0033] In Fig. 4, exhaust quality of the fuel supply system 22 of the present invention and exhaust quality of a fuel supply system using only fuel injection from a fuel injection valve are compared with variation in fuel supply pressure under running conditions of engine speed of 4000 rpm and brake mean effective pressure P_{me} of 400 kPa. With the fuel supply system 22 using only fuel injected from a fuel injection valve, fuel supply

pressure has a lower limit threshold of 250 kPa, while the fuel supply system 22 of the present invention can produce fuel spray which can suppress HC concentration in the exhaust gas limited to about 180 ppm, which is about the same as a conventional carburetor, even if the fuel supply pressure to the fuel injection valve is reduced to 0 kPa. Specifically, the fuel supply system 22 of the present invention makes it possible to sufficiently atomize fuel even if the fuel supply pressure is reduced to almost 0 kPa, whereas sufficient atomization of the fuel is not obtained with the fuel supply system using only fuel injection from a fuel injection valve unless the fuel supply pressure is set to at least 250 kPa.

[0034] Accordingly, it is possible to make a fuel pump connected to the fuel injection valve 24 small in size, and to reduce power consumption, and it is also possible to reduce the cost of fuel piping provided between the fuel injection valve 24 and the fuel pump. Instead of using the fuel pump, it is also possible to supply fuel to the fuel injection valve 24 using only head pressure from a fuel tank arranged above the fuel injection valve 24, and to meter fuel by turning the fuel injection valve 24 on and off.

[0035] Because it is possible to perform adequate fuel atomization in this way, it becomes possible to shorten the length of an intake pipe from the fuel passage organizer 22 to the intake port 16, and it is possible to reduce the overall size of an engine including the intake system.

[0036] The fuel injection valve 24 can be fitted into the intake path organizer 23 with any orientation as long as fuel is supplied to the fuel passage 34, so it is possible to increase the degree of freedom with respect to arranging the fuel injection valve 24. However, if the fuel injection valve 24 is fitted so that it is orthogonal to the intake path 30 as in this embodiment, it is possible to reduce the overall size of the engine including the intake system by shortening the intake system.

[0037] Fig. 5 shows a comparison of exhaust quality of the fuel supply system 22 of the present invention and exhaust quality of a fuel supply system using only fuel injected from a fuel injection valve under running conditions of engine speed of 4000 rpm and brake mean effective pressure P_{me} of 400 kPa with variation in fuel injection timing (crank angle before OTDC). As is clear from Fig. 5, there is no variation in exhaust quality with the fuel supply system 22 of the present invention even if the injection timing of the fuel injection valve 24 is varied, while the exhaust quality varies according to variation in injection timing with the fuel supply system 22 using only fuel injection from a fuel injection valve. Specifically, with the fuel supply system 22 of the present invention, fuel is metered using intake negative pressure according to running conditions of the engine E and sucked into the intake path 30, and the fuel injection valve 24 preferably supplies fuel according to the amount of fuel sucked to the intake path 30, which means that it is possible to sufficiently atomize the fuel and obtain good exhaust quality without controlling injection timing of the fuel injection valve 24 with high precision. However, with fuel supply using only fuel injection from a fuel injection valve, adequate fuel atomization is not obtained unless the fuel injection timing is controlled with high precision and exhaust quality is bad.

[0038] Fig. 6 shows a comparison of exhaust quality of the fuel supply system 22 of the present invention and exhaust quality of a fuel supply system using only fuel injection from a fuel injection valve under low engine running conditions of 2000 rpm with variation in brake mean effective pressure P_{me}. As is clear from Fig. 6, with the fuel supply system 22 of the present invention, when brake mean effective pressure P_{me} is low, namely when the engine is running at a low speed of 2000 rpm or at high load, fuel is sufficiently atomized and good exhaust quality is obtained, compared to the fuel system using only fuel injection from a fuel injection valve that can not sufficiently atomize the fuel leading to degradation of exhaust quality. Specifically, with the fuel supply system 22 of the present invention atomization is also carried out using assist air, which means that it is possible to sufficiently atomize the fuel even under high load, low speed running conditions.

[0039] In a conventional engine in which fuel is supplied using a fuel injection valve, it is difficult to handle fuel supply over a wide driving range from idle opening of the throttle valve to fully open, with a single fuel injection valve, and an additional fuel injection valve is arranged upstream of the throttle valve, but it is possible to use the fuel supply system of the present invention instead of the additional fuel injection valve, and the intake system in this type of situation will now be described in a second embodiment.

[0040] In Fig. 7, a fuel injection valve 52 for mainly handling fuel to be supplied to an engine E is attached to an intake pipe 53 connected to an intake port 16 of the engine E, and the intake pipe is connected to an air cleaner 29 through a throttle body provided with a throttle valve, and a fuel supply system 22'.

[0041] The fuel supply system 22' has the same structure as the fuel supply system 22 of the first embodiment described above except for the fact that the throttle valve is not provided, and supplements fuel when an amount of fuel injected from the fuel injection valve 52 is insufficient.

[0042] According to the second embodiment, it is possible to avoid increasing intake resistance due to the fuel supply system 22' regardless of the fact that the fuel system 22' is arranged upstream of the throttle valve 23 in place of the additional fuel injection valve.

[0043] Fig. 8 shows a third embodiment of the present invention. A fuel injection system with a throttle valve 32 is connected to an intake port 16 of an engine mainly responsible for supply of fuel to the engine E, and an additional fuel injection valve 54 is attached between the throttle valve 32 and the air cleaner 29.

[0044] The injection direction of the additional fuel injection valve 54 is set to a direction coincident with a central axis of the narrowed section 31 of the fuel supply system.

[0045] According to the third embodiment, in the fuel supply system 22 fuel is injected from the additional fuel injection valve 54 towards fuel sucked to the air flow from the respective fuel induction ports 35... at the inside of the narrowed section 31, and it is possible to make the concentration of mixture uniform when the throttle valve 32 is fully open.

[0046] Fig. 9 shows a fourth embodiment of the present invention. While in the third embodiment the injection direction of the additional fuel injection valve 54 is set to a direction coincident with a central axis of the narrowed section 31 of the fuel supply system, in the fourth embodiment the injection direction of the additional fuel injection valve 54 is set so as to pass through the center of a section where the fuel induction ports 35 are provided in the narrowed section 31.

[0047] According to the fourth embodiment, fuel injected from the additional fuel injection valve 54 is made to collide with fuel sucked from the fuel induction ports 35... without being obstructed by the fully open throttle valve 32 thereby being more effectively dispersed. As a result it is possible to make air-fuel mixture concentration extremely uniform

[0048] Embodiments of the present invention have been described in detail above, but the present invention is not limited to these embodiments and various design changes can be carried out without departing from the spirit and scope of the present invention as defined in the attached claims.

[0049] To promote atomization of fuel in an engine fuel supply system, a fuel injection valve fitted in an intake path organizer forming an intake path communicating with an air cleaner has a fuel passage for guiding fuel from the fuel injection valve, a fuel induction port having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer.

[0050] A fuel induction port 35 opens to an intake path 30 in a direction orthogonal to air flow circulating in the intake path 30.

Claims

1. An engine fuel supply system, with a fuel injection valve (24) fitted in an intake path organizer (23) forming an intake path (30) communicating with an air cleaner (29), having a fuel passage (34) for guiding fuel from the fuel injection valve (24), a fuel induction port (35) having one end communicating with the fuel passage (34) and the other end communicating with the intake path (30), and an air bleed passageway (49) having one end communicating with the intake path (30) further upstream than the fuel induction port (35) and the other end communicating with the fuel passageway (34), all provided in the intake path organizer (23), wherein the other end of the fuel induction port (35) is opened to the intake path (30) in a direction orthogonal to an air flow circulating in the intake path (30).

2. The engine fuel supply system of claim 1, wherein the fuel induction port (35) is provided in the intake path organizer (23) opening to an inner surface of the intake path (30).

3. The engine fuel supply system of claim 2, wherein the other ends of a plurality of fuel induction ports (35) open to an inner surface of the intake path at mutually opposite positions.

4. An engine fuel supply system, with a fuel injection valve (24) fitted in an intake path organizer (23) forming an intake path (30) communicating with an air cleaner (29), having a fuel passage (34) for guiding fuel from the fuel injection valve (24), a fuel induction port (35) having one end communicating with the fuel passage (34) and the other end communicating with the intake path (30), and an air bleed passageway (49) having one end communicating with the intake path (30) further upstream than the fuel induction port (35) and the other end communicating with the fuel passageway (34), all provided in the intake path organizer (23), wherein a narrowed section (31) constituting part of the intake path (30) is provided in the intake path organizer (23) with a smaller internal diameter than the intake path (30) at an upstream side of the narrowed section(31), and the other end of the fuel induction port (35) opens to an inner surface of the narrowed section (31) in a direction orthogonal to an air flow circulating in the narrowed section (31).

Fig. 1

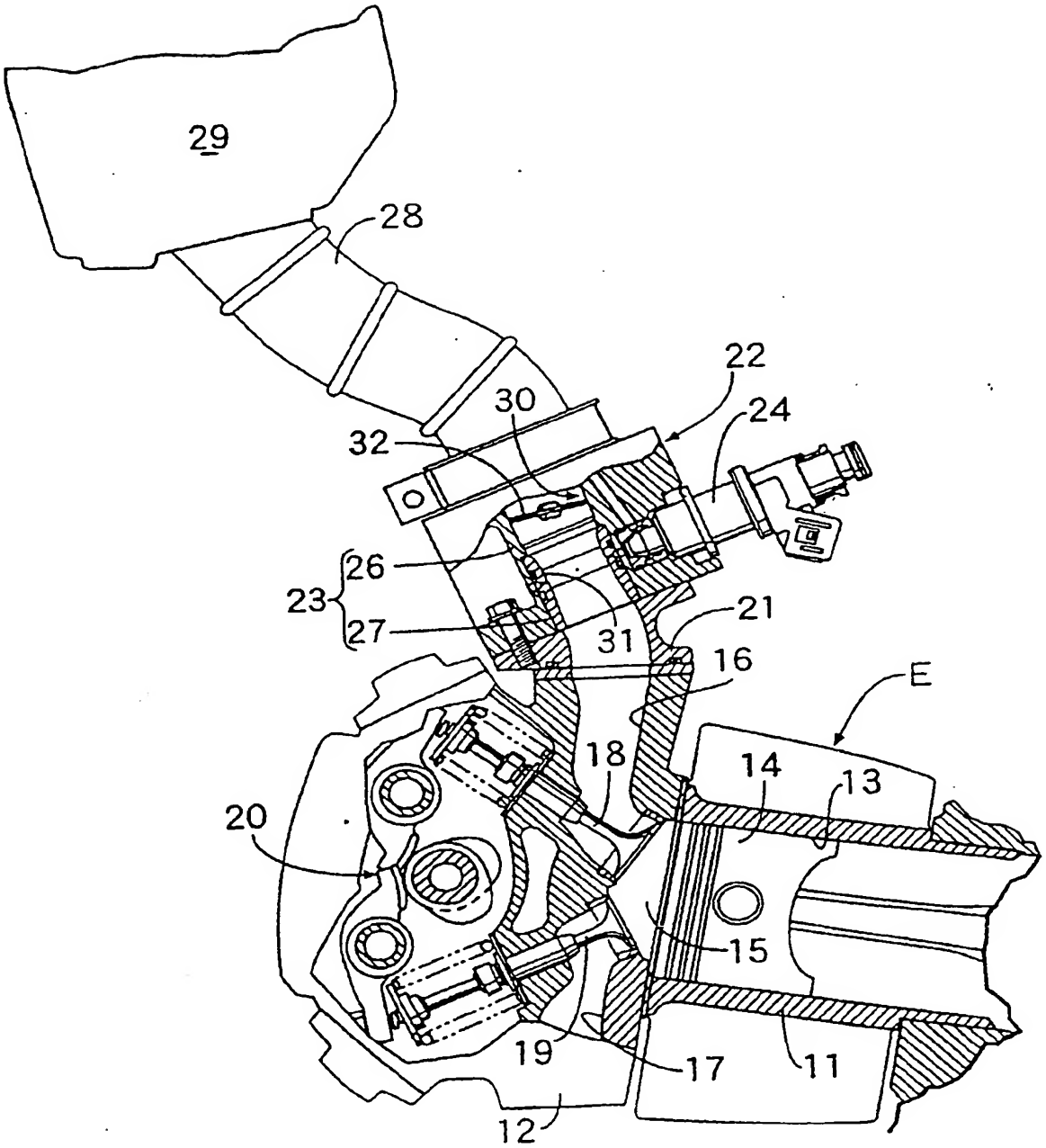


Fig. 2

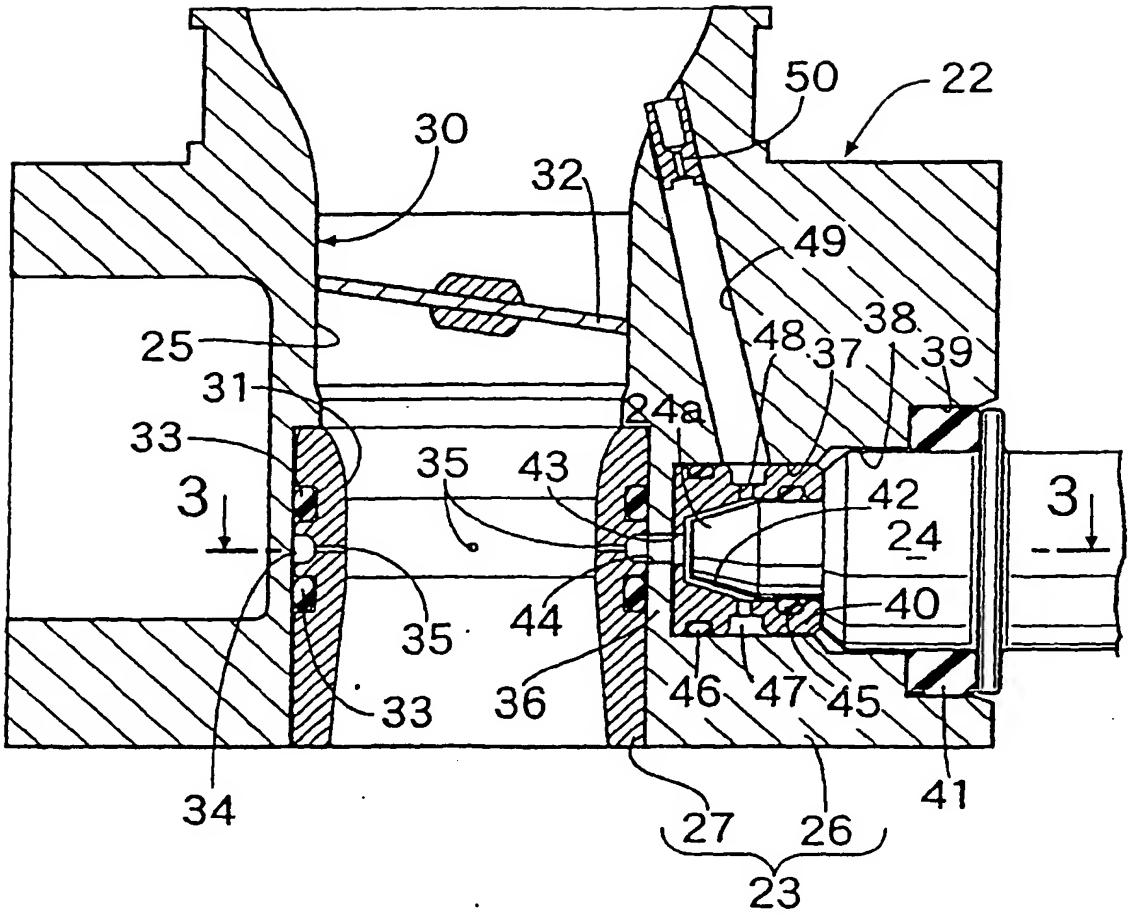


Fig. 3

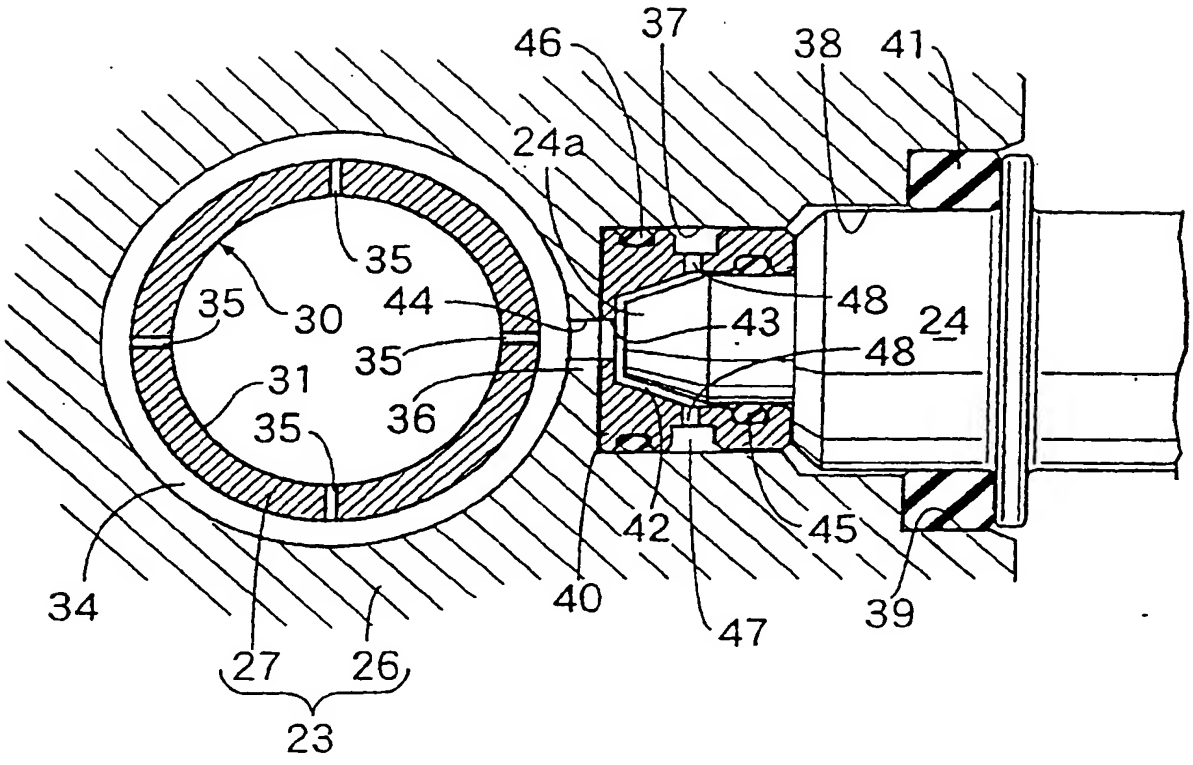


Fig. 4

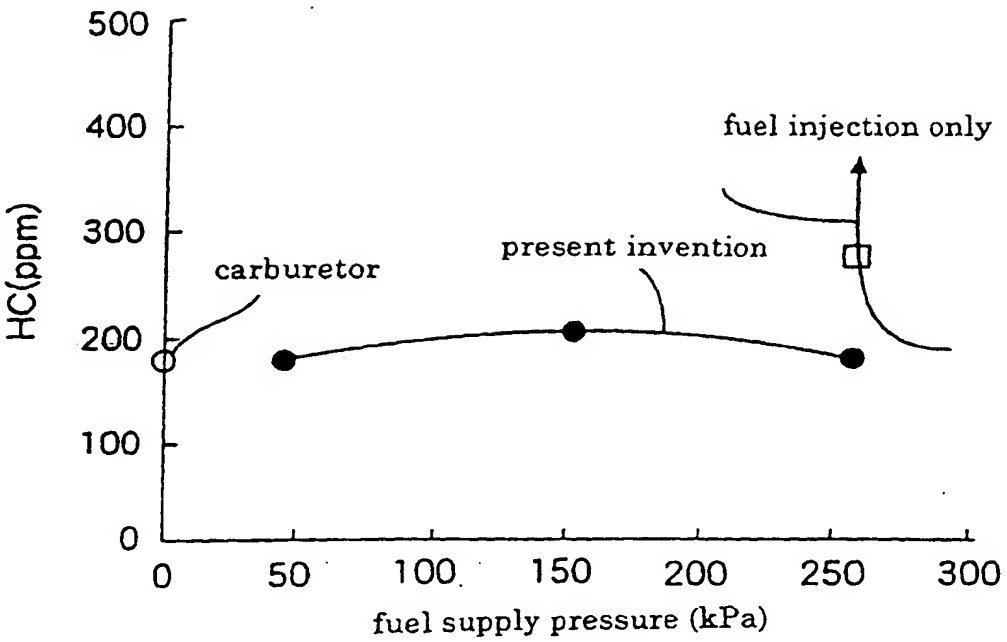


Fig.5

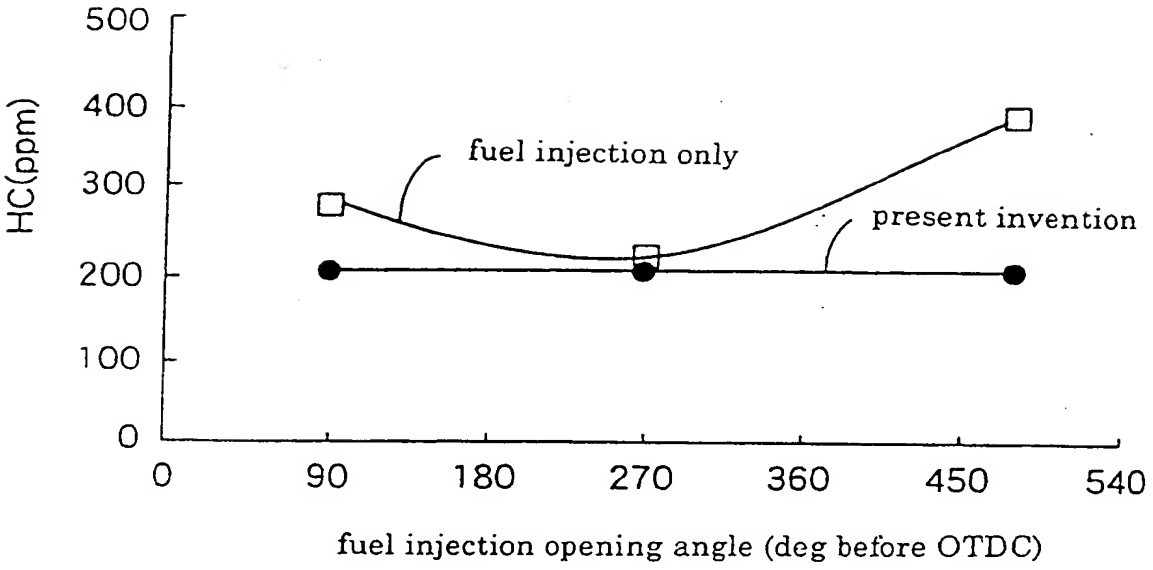


Fig. 6

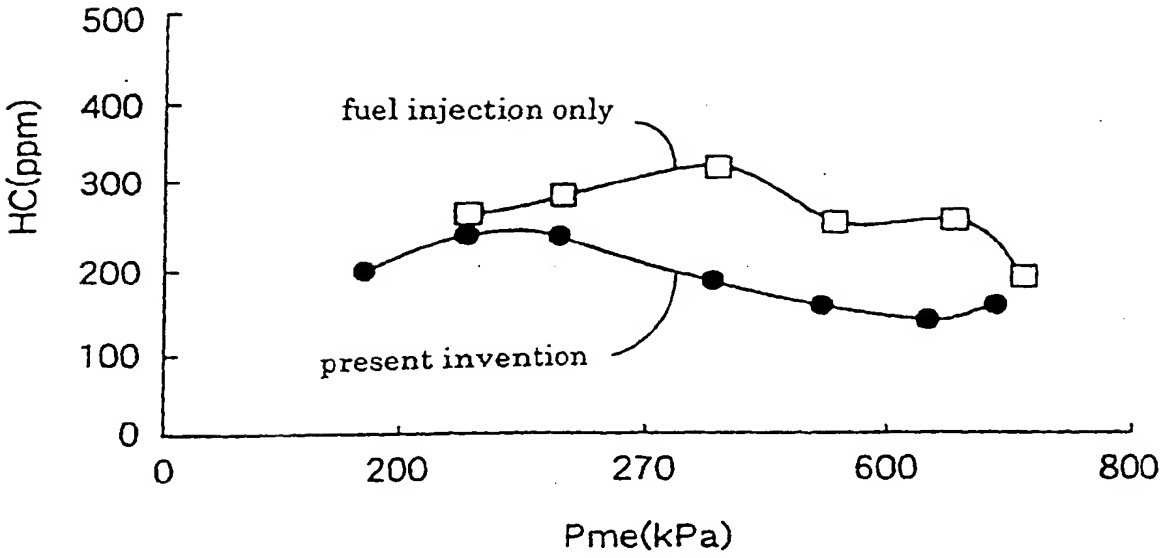


Fig. 7

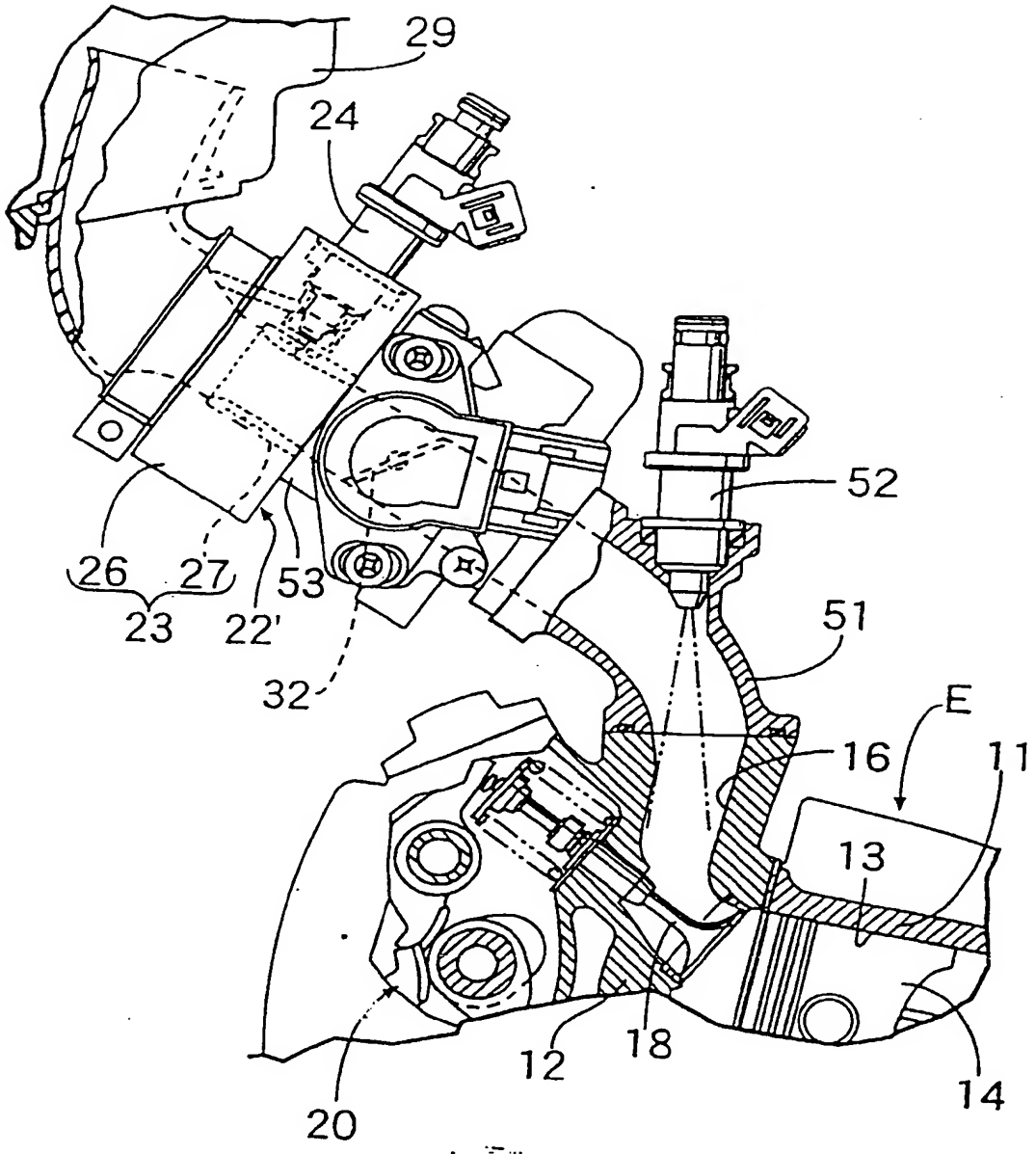


Fig. 8

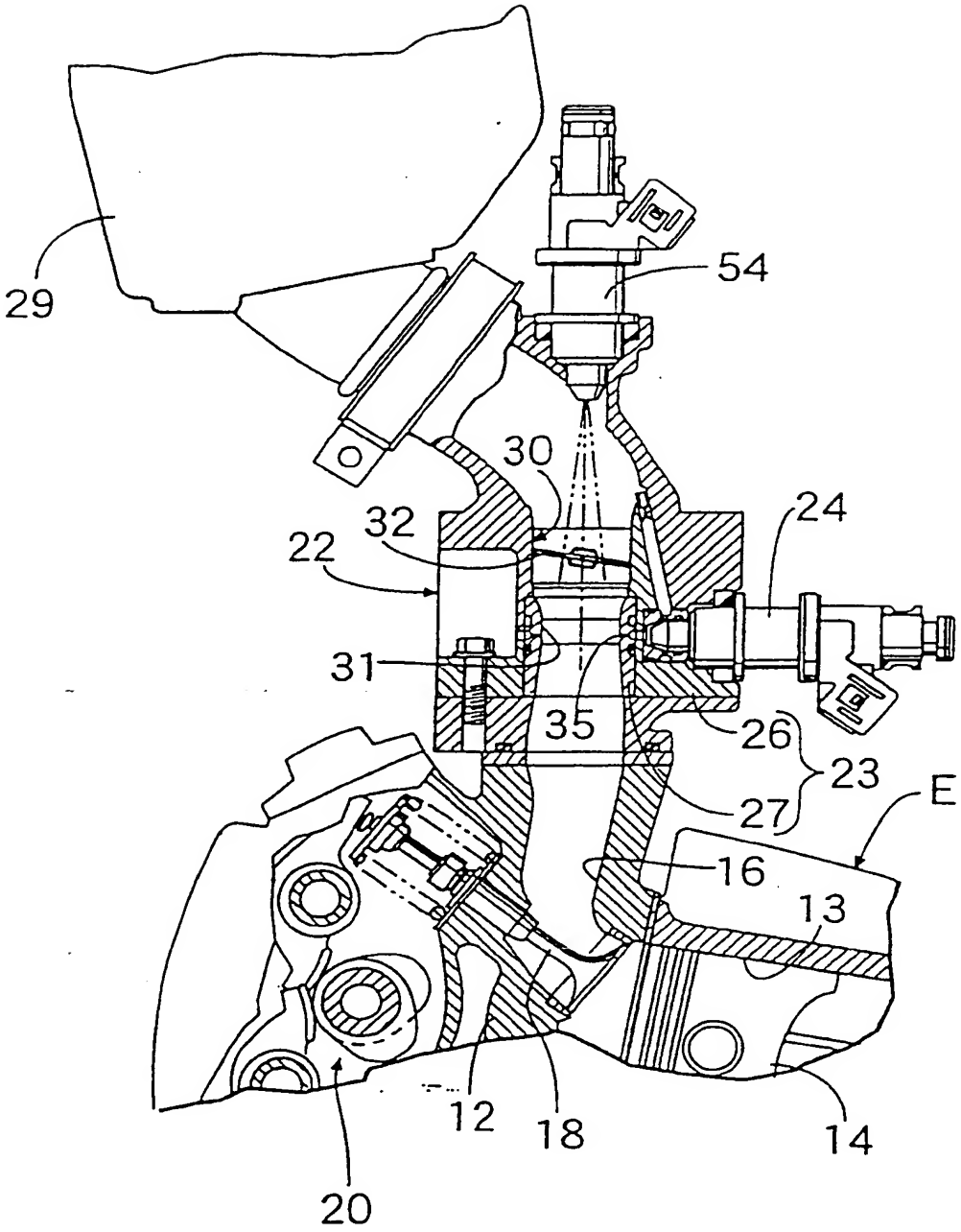
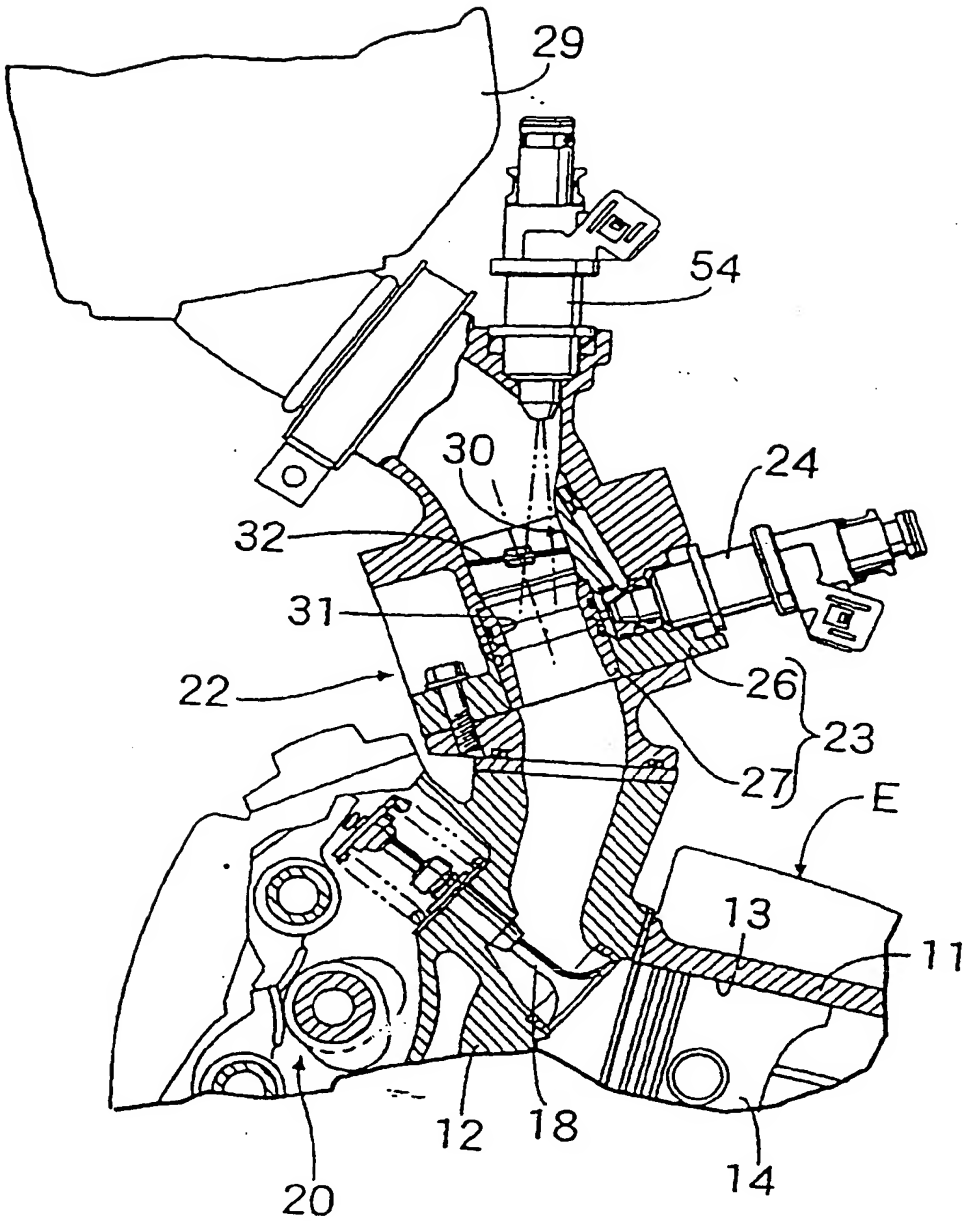


Fig. 9



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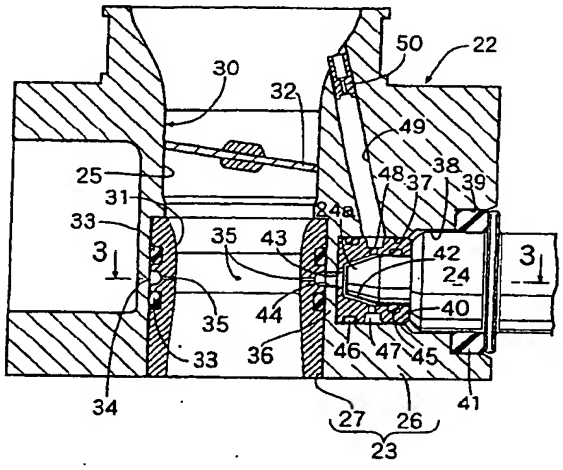
(54) Engine fuel supply system

(57) To promote atomization of fuel in an engine fuel supply system, a fuel injection valve (24) fitted in an intake path organizer (23) forming an intake path communicating with an air cleaner has a fuel passage for guiding fuel from the fuel injection valve (24), a fuel induction port (35) having one end communicating with the fuel passage and the other end communicating with the intake path, and an air bleed (49) passageway having one end communicating with the intake path further upstream than the fuel induction port and the other end communicating with the fuel passageway, all provided in the intake path organizer.

A fuel induction port (35) opens to an intake path (30) in a direction orthogonal to air flow circulating in the intake path (30).

Fig. 2



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Application Number
EP 00 12 3581

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